Near-Field Cosmological Prospects for BigBOSS
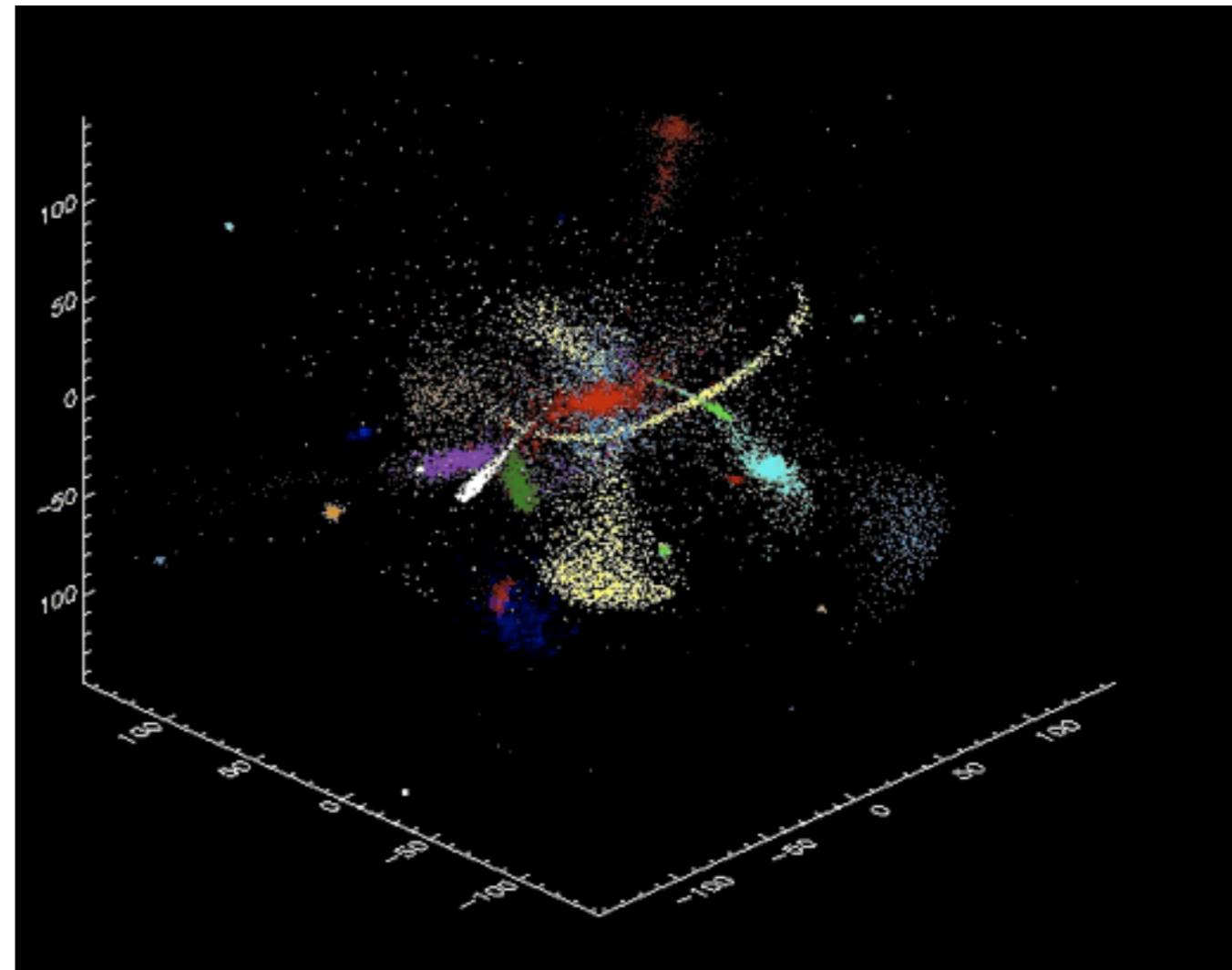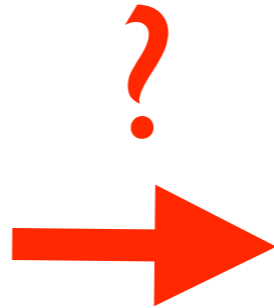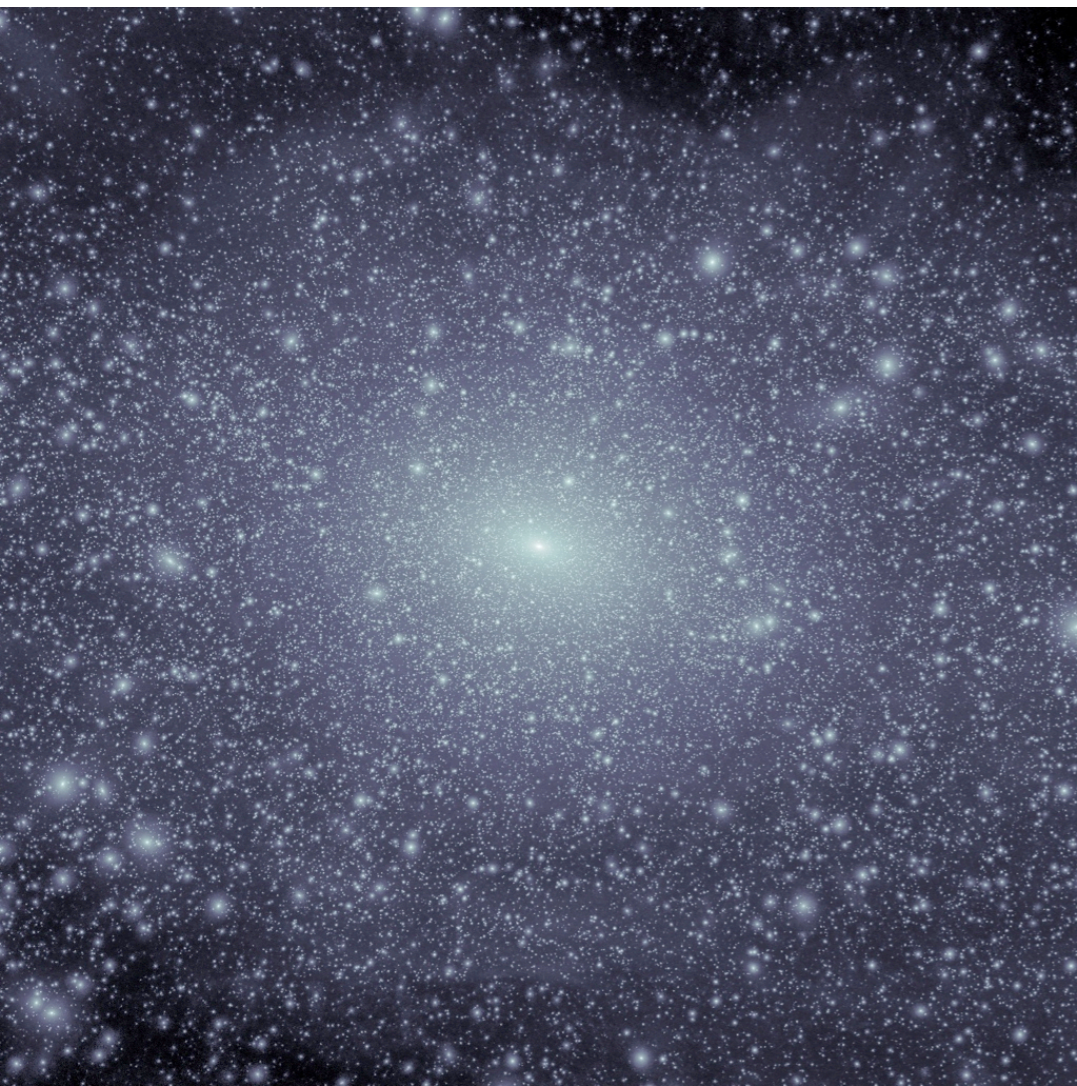
Connie Rockosi

UCO/Lick Observatory
UC Santa Cruz
(with lots of help from colleagues in the SEGUE survey)

Finding the Lowest-Mass Dark Matter Halos

Via Lactea simulation, MW-like DM halo.
Diemand et al. 2008
DM-only.   Substructure
well-resolved to Vmax ~5 km/s, r ~ 8 kpc

Bullock & Johnston 2005
Stellar halo formation simulation based on DM
halo merger history, MW satellite population
constraints. Each color is a surviving or tidally
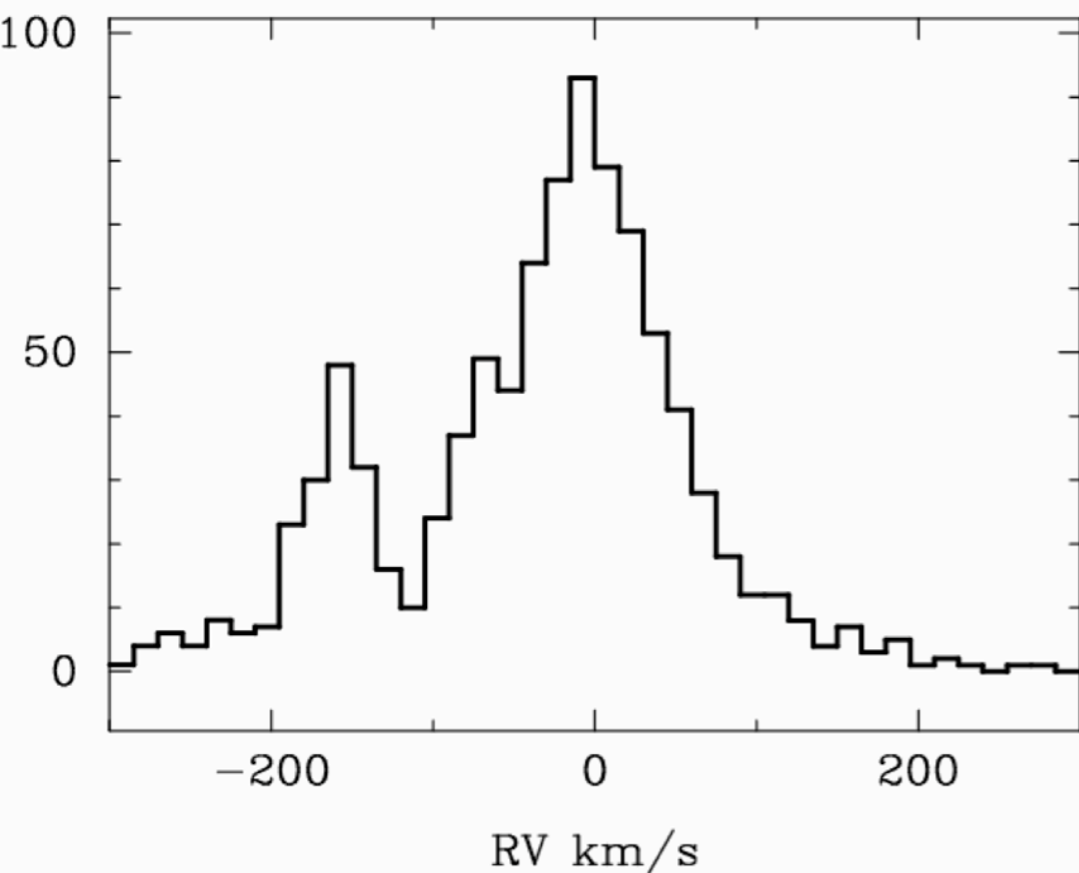disrupted dwarf galaxy, hosted by a DM halo

Observables

New (faint!) dwarf galaxies, confirmed to be in DM halos
(kinematic mass limits)

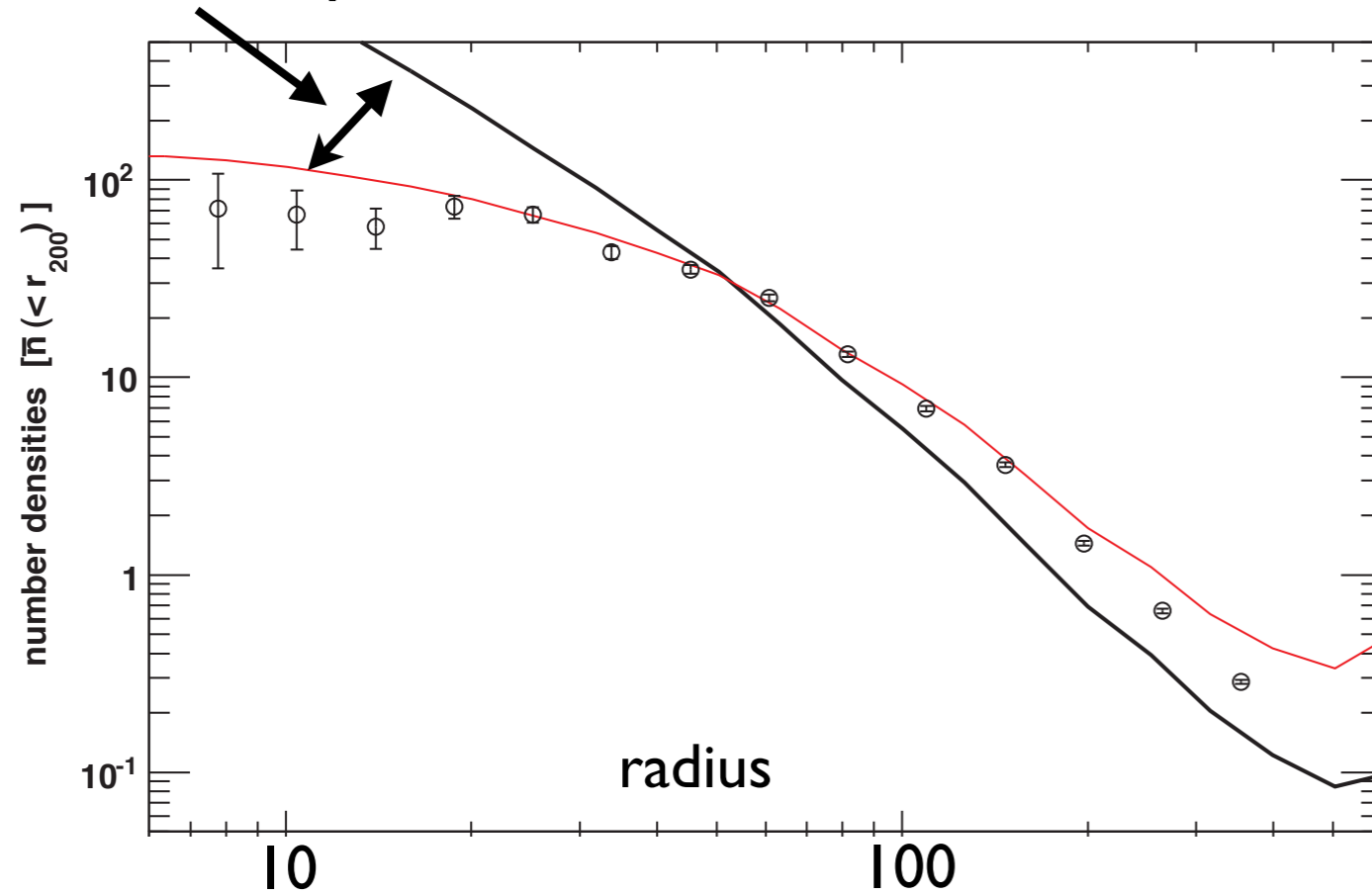Dwarf galaxies, density and velocity substructure
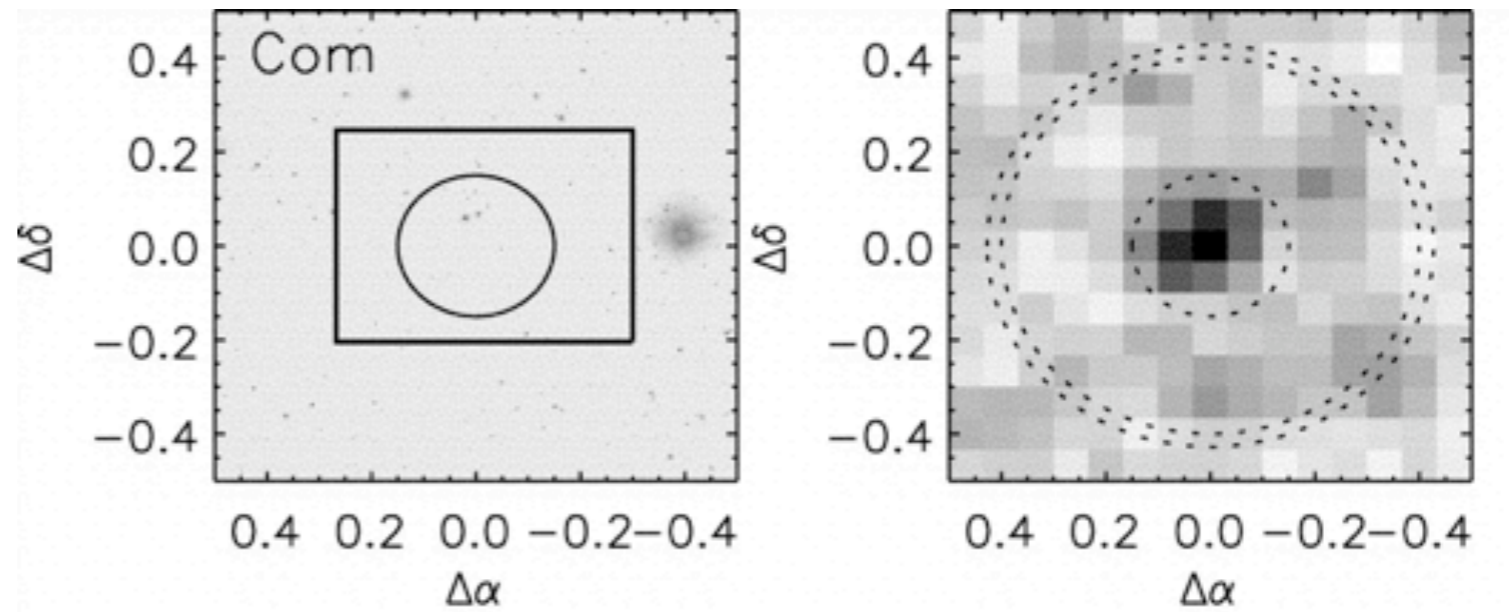
Sgr dSph tails in SEGUE RVs

Sgr dwarf galaxy tidal tails: accretion and tidal disruption in action
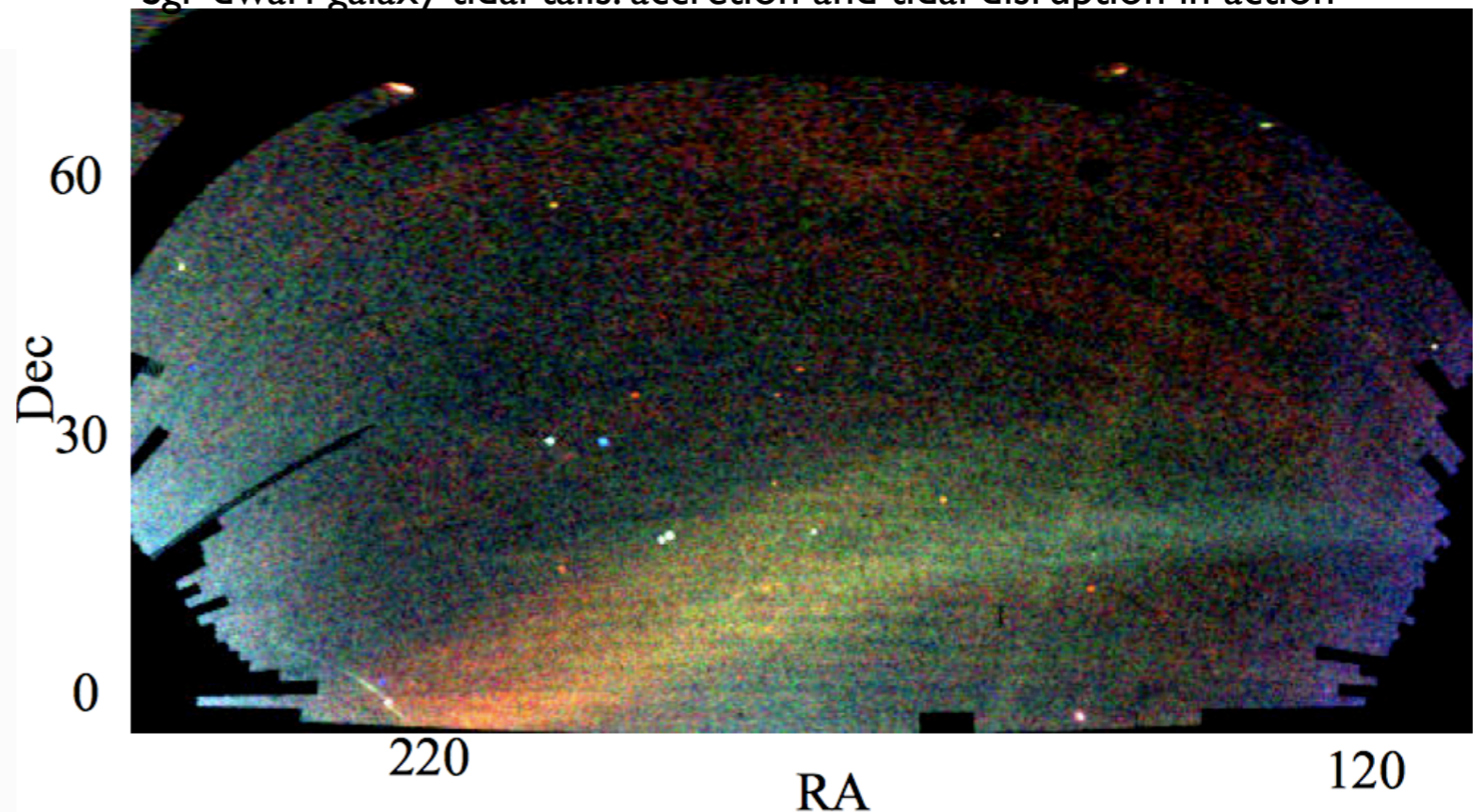
Belokurov et al 2009b (top), 2009a (bot)

Accounting: State of the Art

tidal mass-loss and disruption

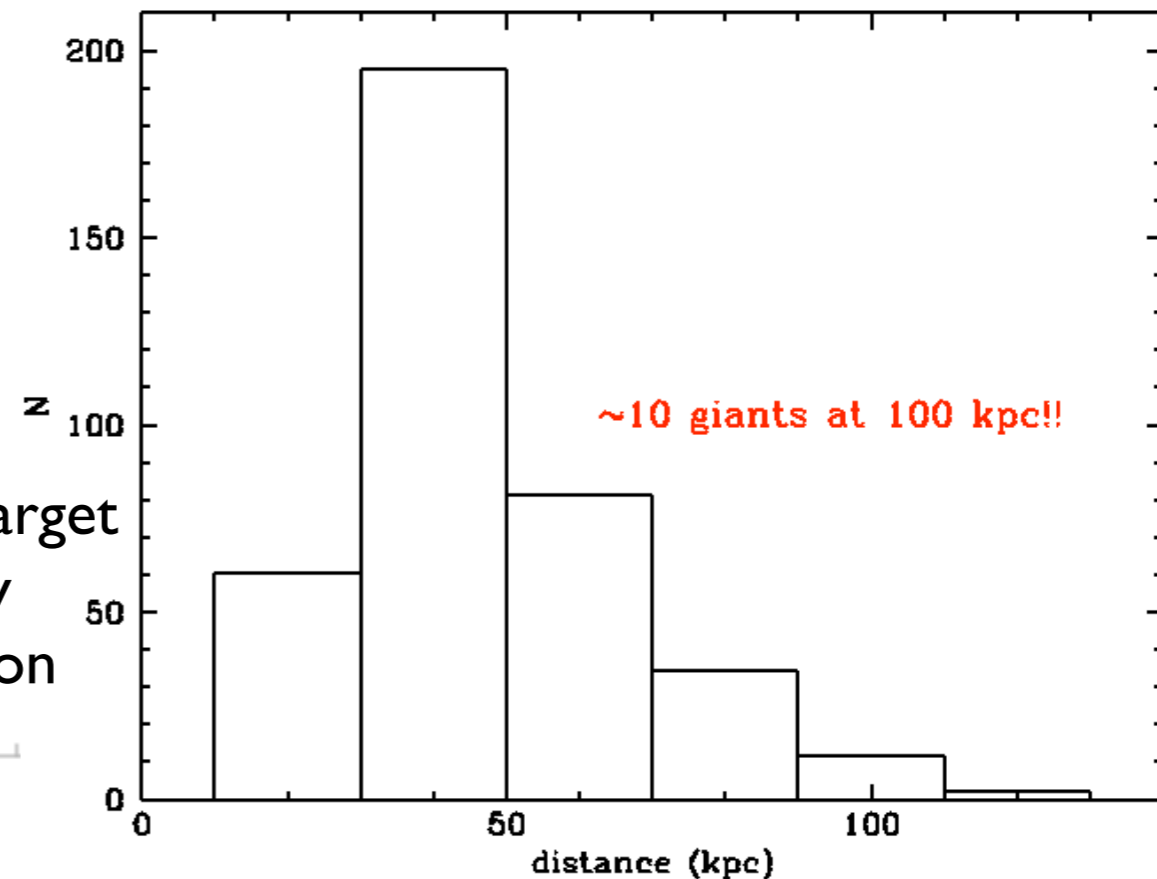number densities [$\bar{n}(<r_{200})$]

radius

subhalo vs DM density in Via Lactea, Diemand et al. 2008 Circles are subhalos, solid black line is total DM density

$F_* \propto M_{sat}^{\alpha}$

$F_* = 10^{-3}$

$F_* = 10^{-3} \, M_{sat}$

$F_* = 10^{-3} \, M_{sat}^2$
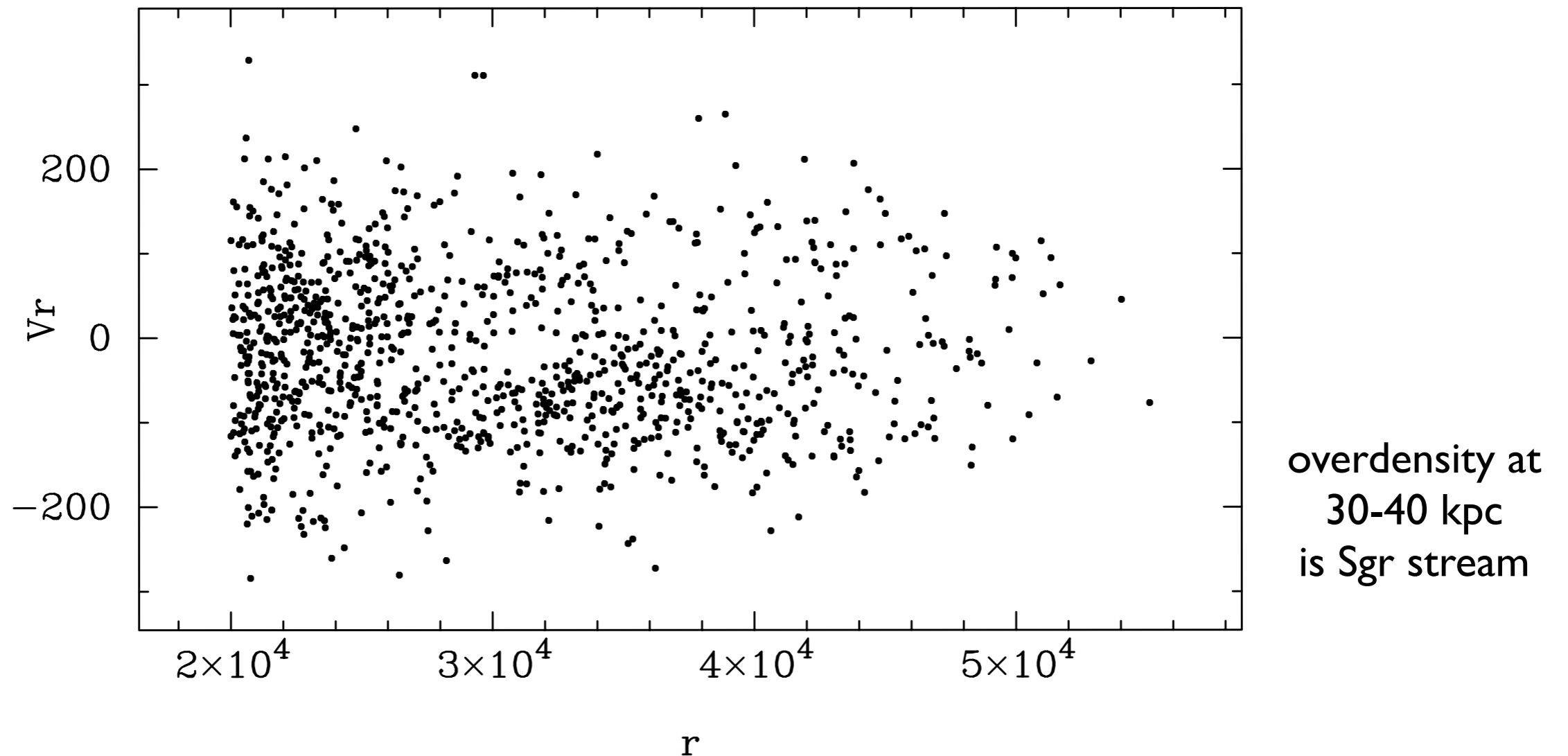
N_{obs}

M_V, [mag]
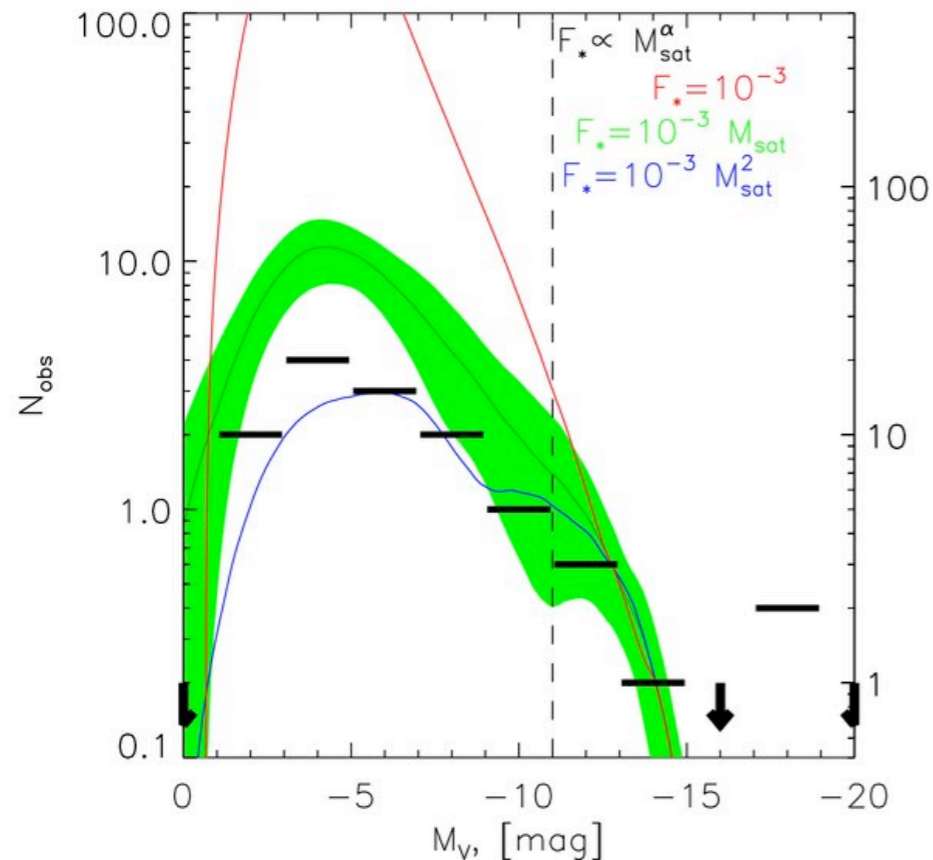
Koposov et al. 2008
Updated "missing satellite" plot, e.g., Moore et al. 1999. Observed MW satellites (black lines) Model for stellar fraction in DM halos

Finding DM Halo Remains:
Stellar tracers of substructure in the distant halo

One 7-square degrees SEGUE-2 field. Good targets are scarce

k-giants, g<18.5

plateID 3485 locationID 0468 designID 0673

RA,Dec = 242.44,45.30
Gal. l,b = 71.34,46.89

BHBs

Most luminous giant candidates red

SEGUE-2 K- and M-giant target selection and efficiency
H. Morrison and J. Johnson

~10 giants at 100 kpc!!

The Distant Halo in SEGUE: BHBs

overdensity at
30-40 kpc
is Sgr stream
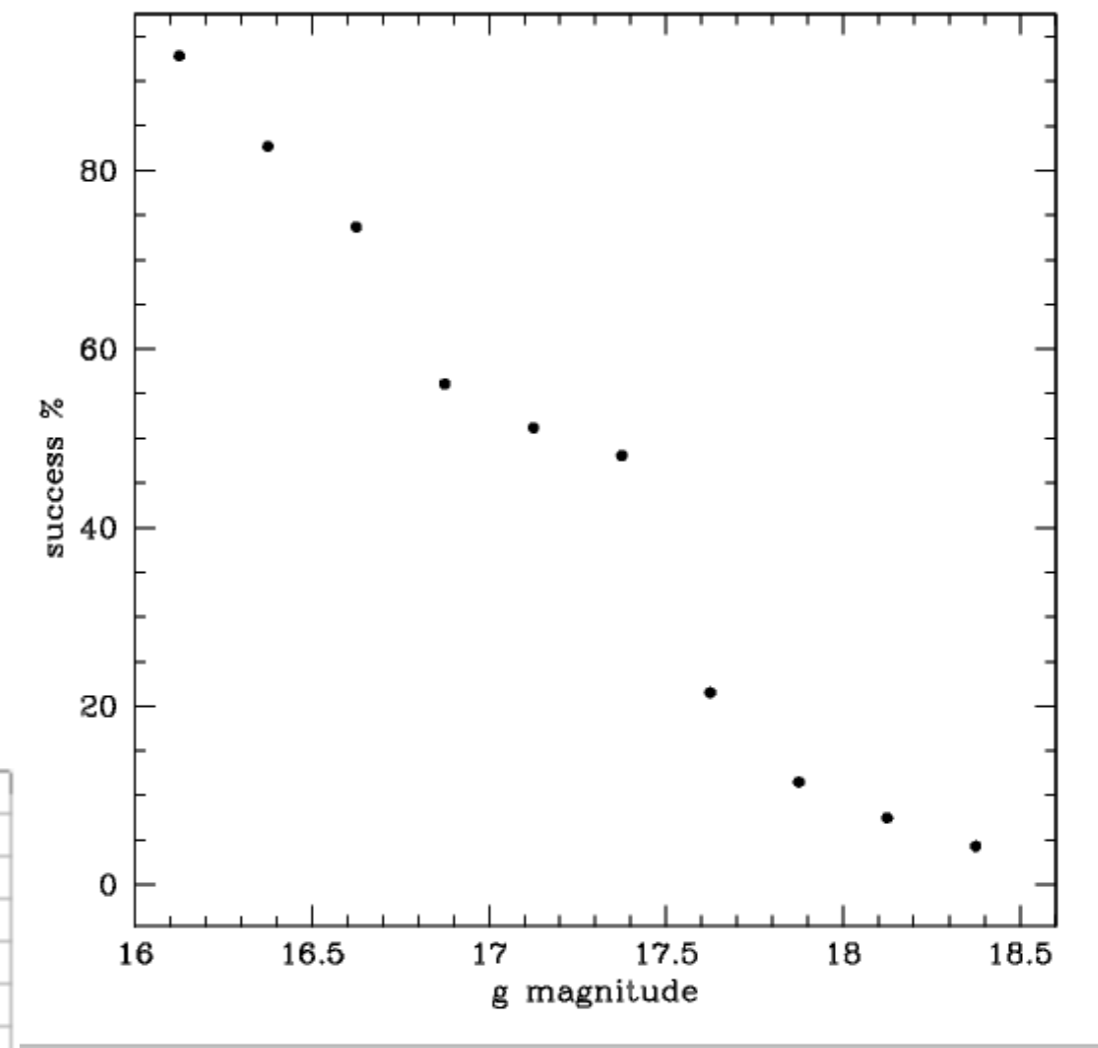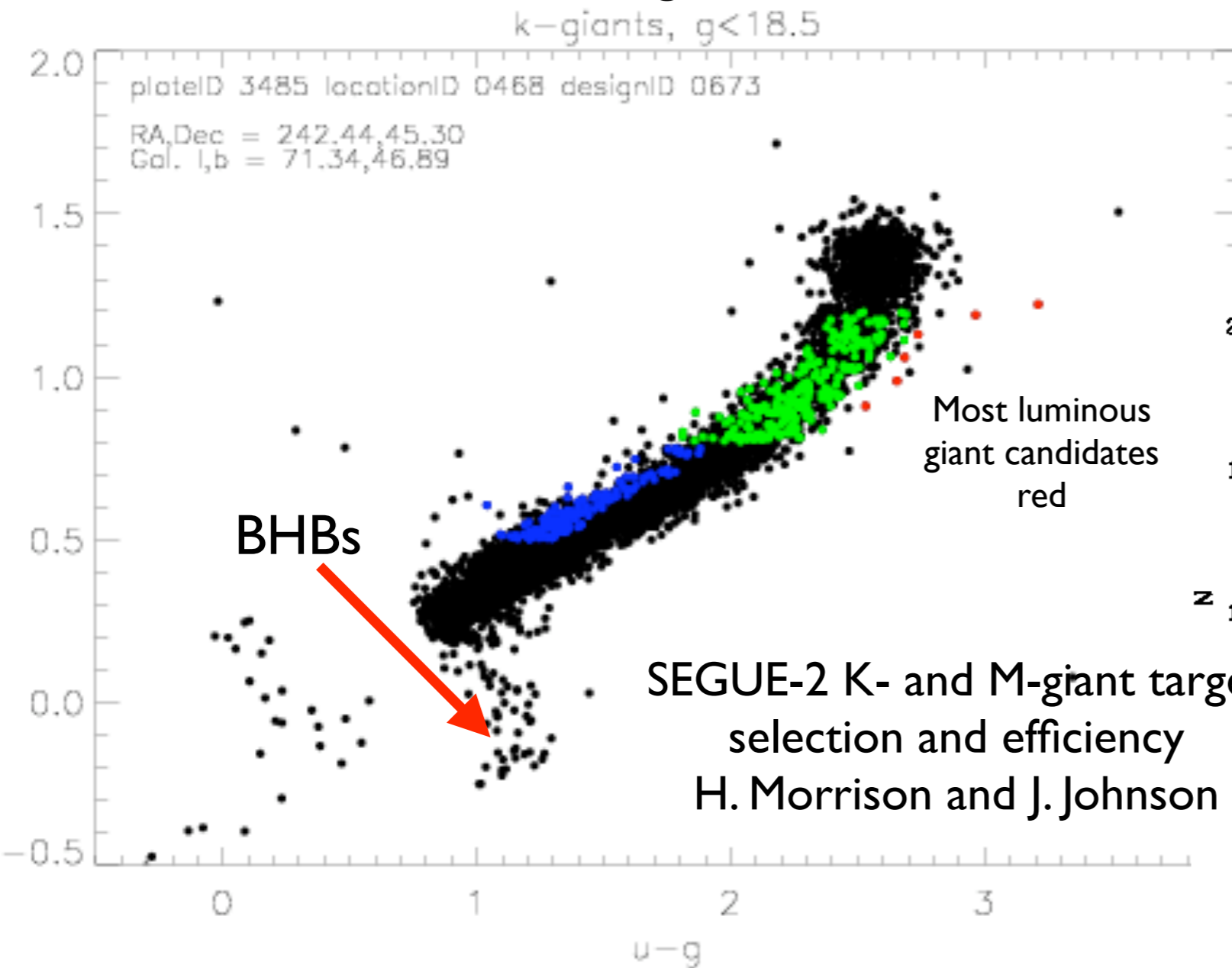
- 1056 BHBs r>20 kpc

  - final catalog will be Xue et al. 2009

Halo Mass Profile

SDSS+SEGUE BHBs

M(r<60kpc):

$4.0 \pm 0.7 \times 10^{11} M_\odot$
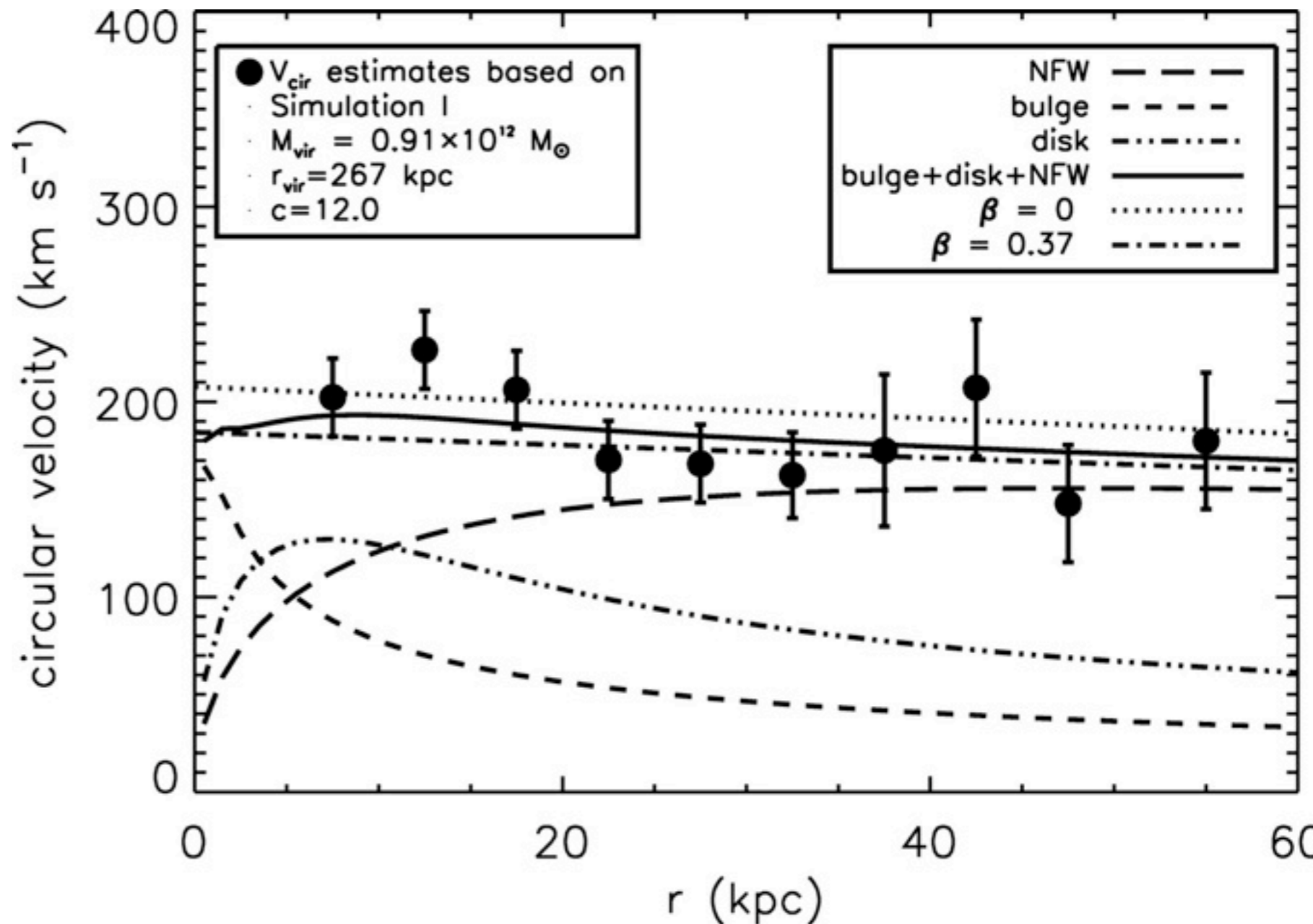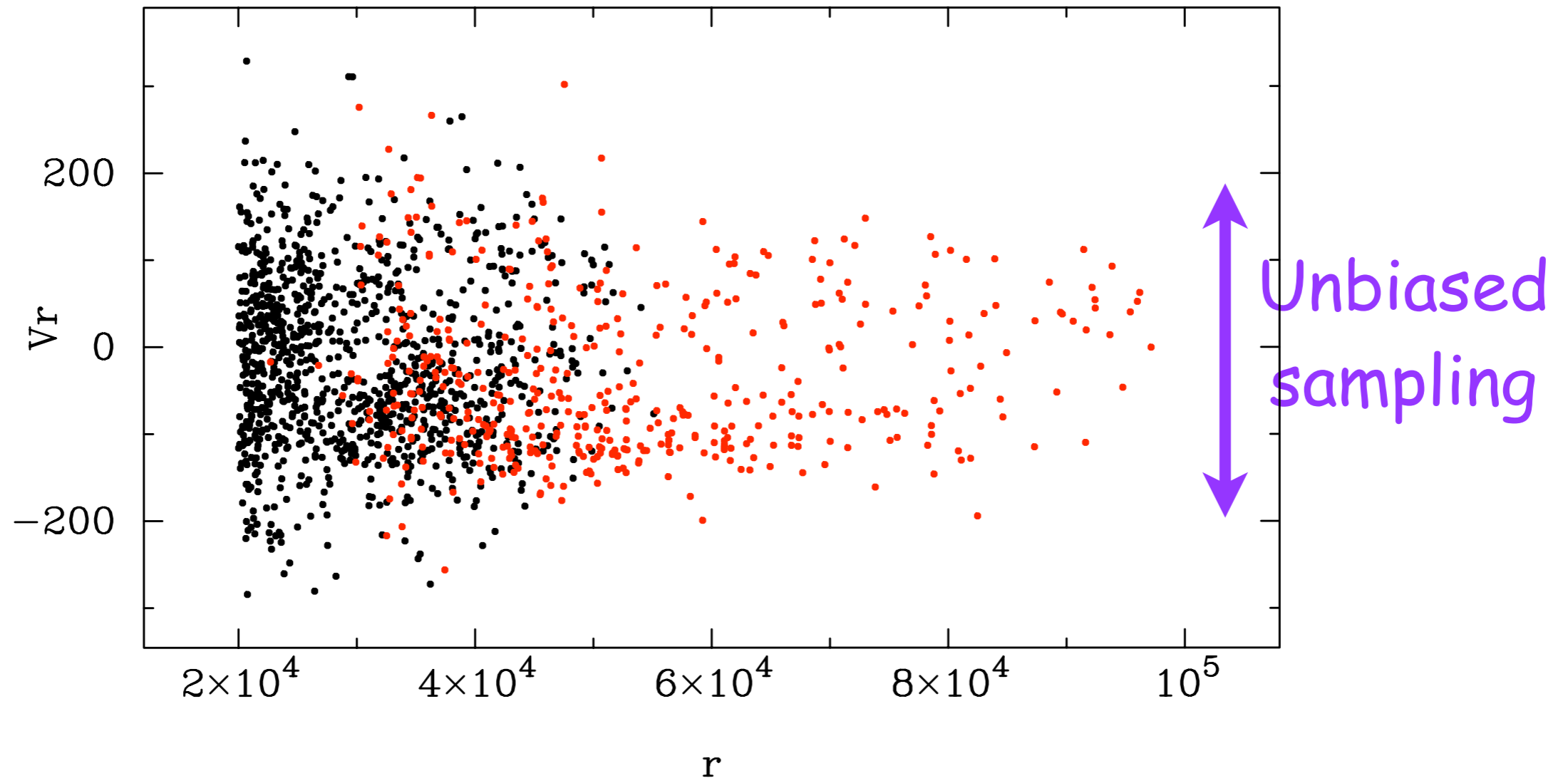
Use DM halo profiles from simulations to get to Mvir

BHB density limits sample size
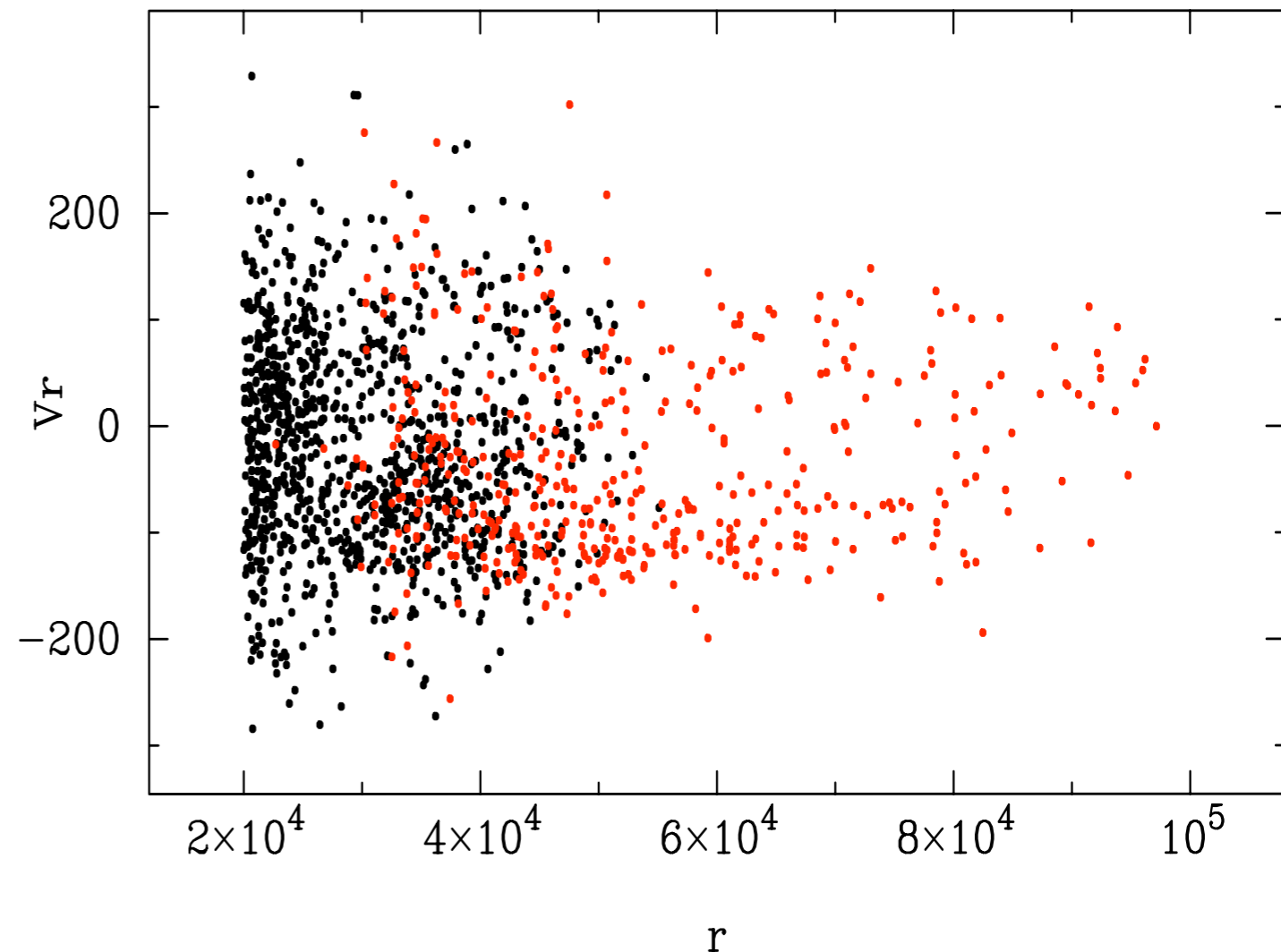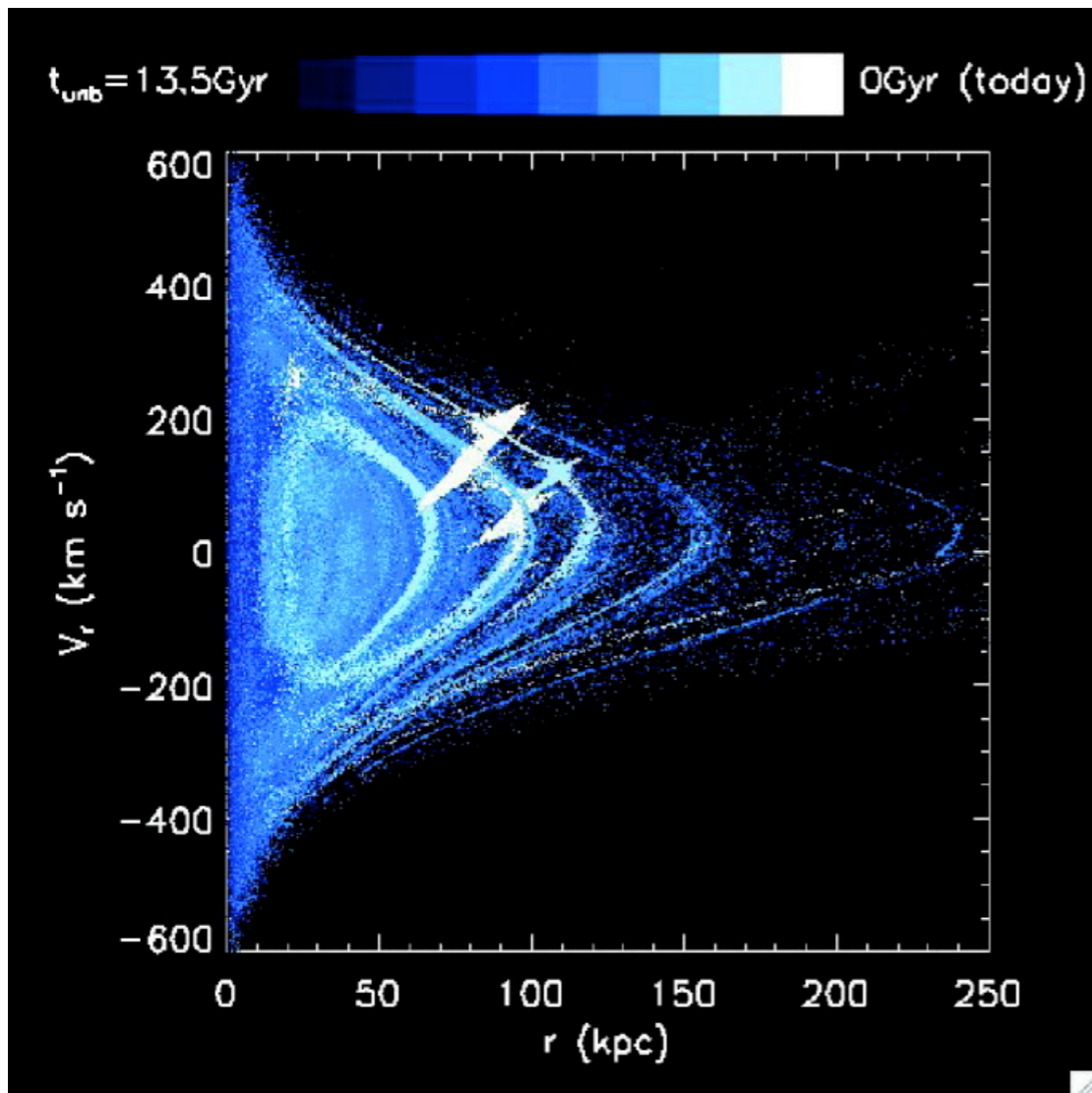

Xue et al. 2008

The Distant Halo in SEGUE: K-giants

- 460 K-giants r >~ 30 kpc

- similar clumping at the distance, Vr of Cetus+Sgr

The Distant Halo in SEGUE: Context

- But tracers are still sparse at large r
  - halo should be most clumpy, models make best predictions
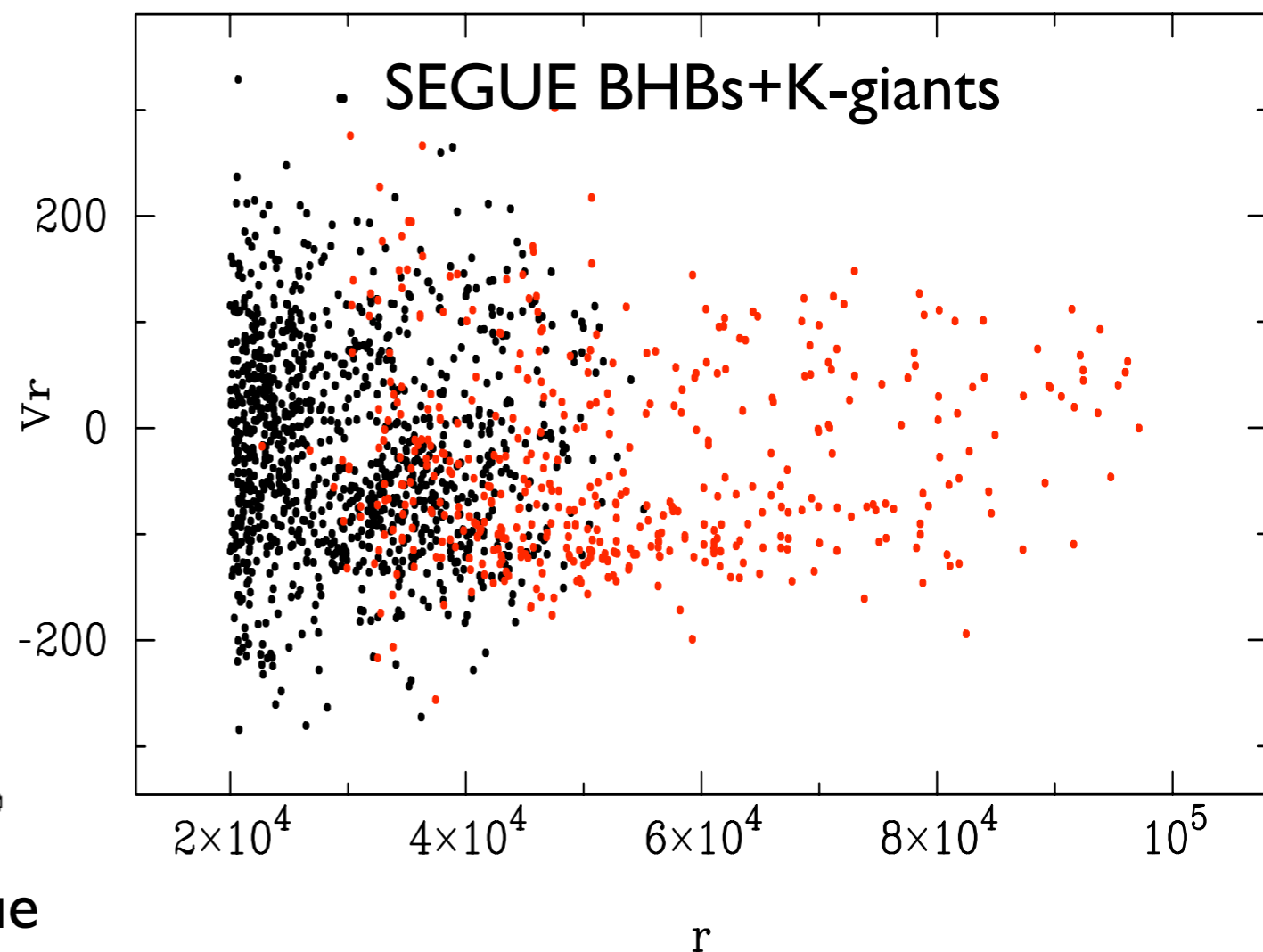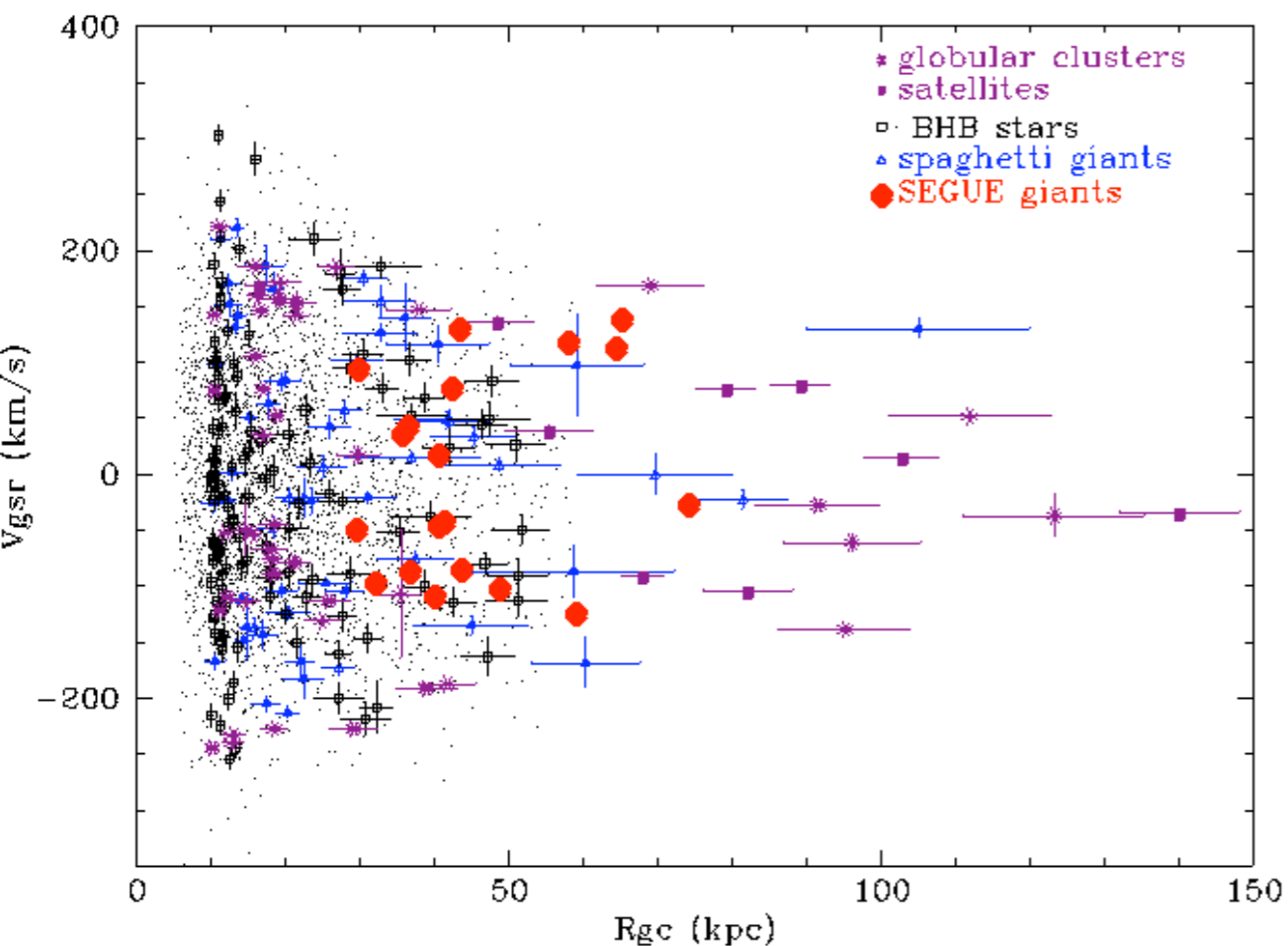
Note different axis scales!

Bullock and Johnston 2005

The Distant Halo in SEGUE: Context

- Progress: factor of 10-100 more halo tracers at d> 30 kpc

Battaglia et al. 2005 compilation + Xue
BHBs + early SEGUE K-giants

# Elements Of Cold Halo Substructure (ECHOS) in the Inner Halo

- substructure in SEGUE UVX MSTO star RV distribution: max. #s + distance: r<20 kpc

- 7 new detections on 137 lines of sight, with Monte Carlo for completeness and significance

- 1/3 of the inner halo volume has 10% of its stars in cold substructure

- remaining undetected inner halo substructure is low contrast, <~ 10%
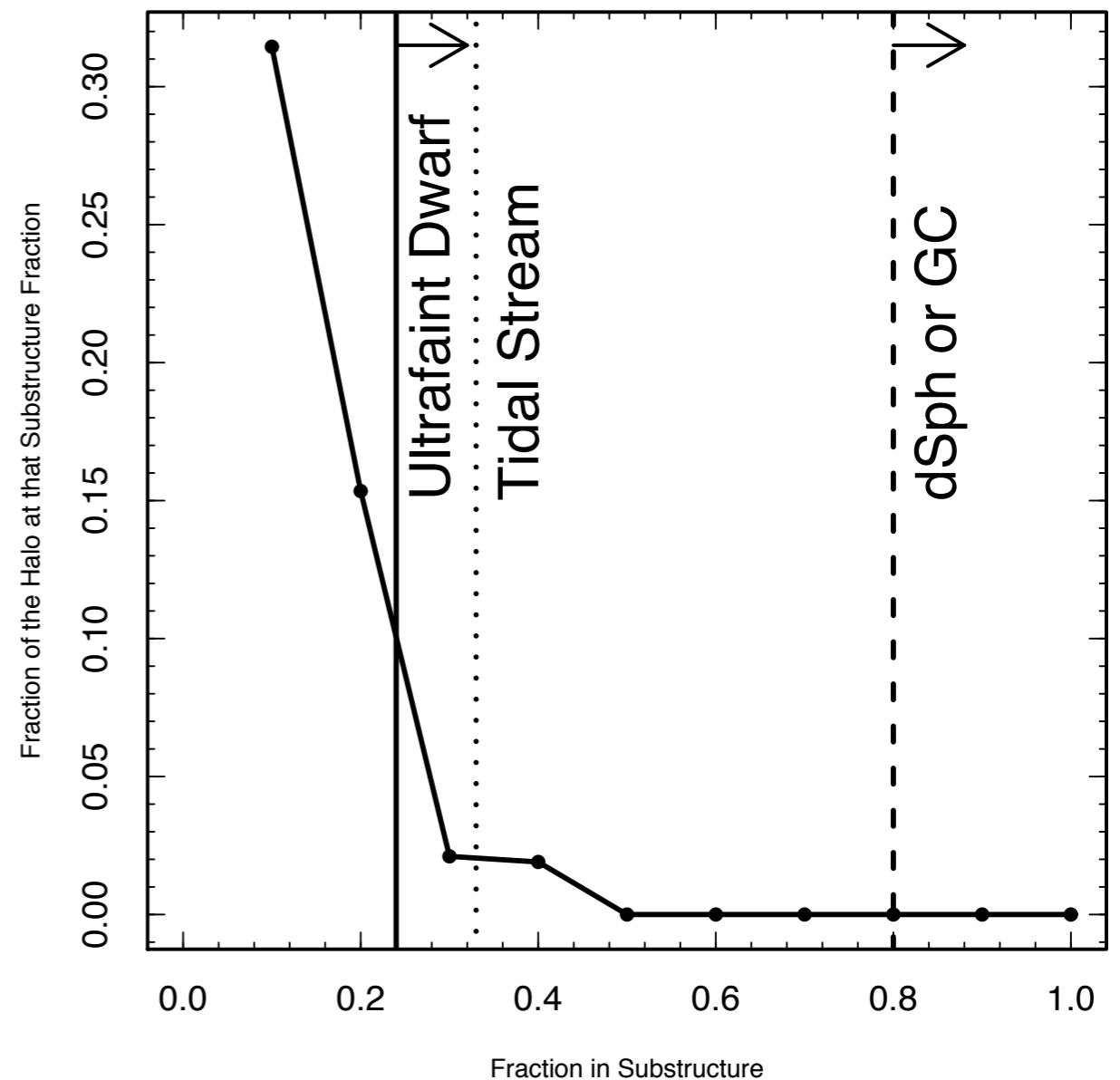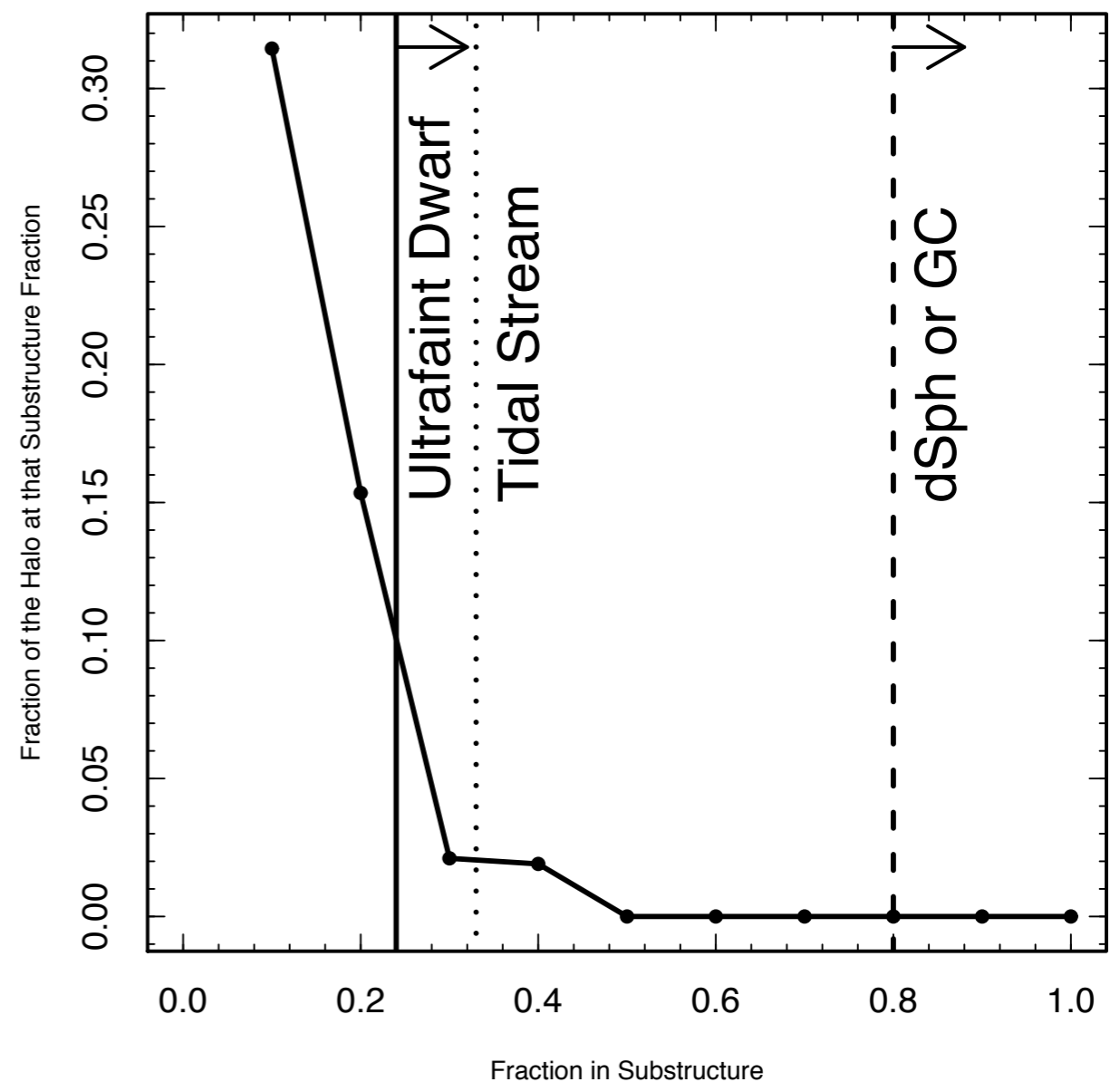

Schlaufman et al. 2009

Elements Of Cold Halo Substructure (ECHOS)
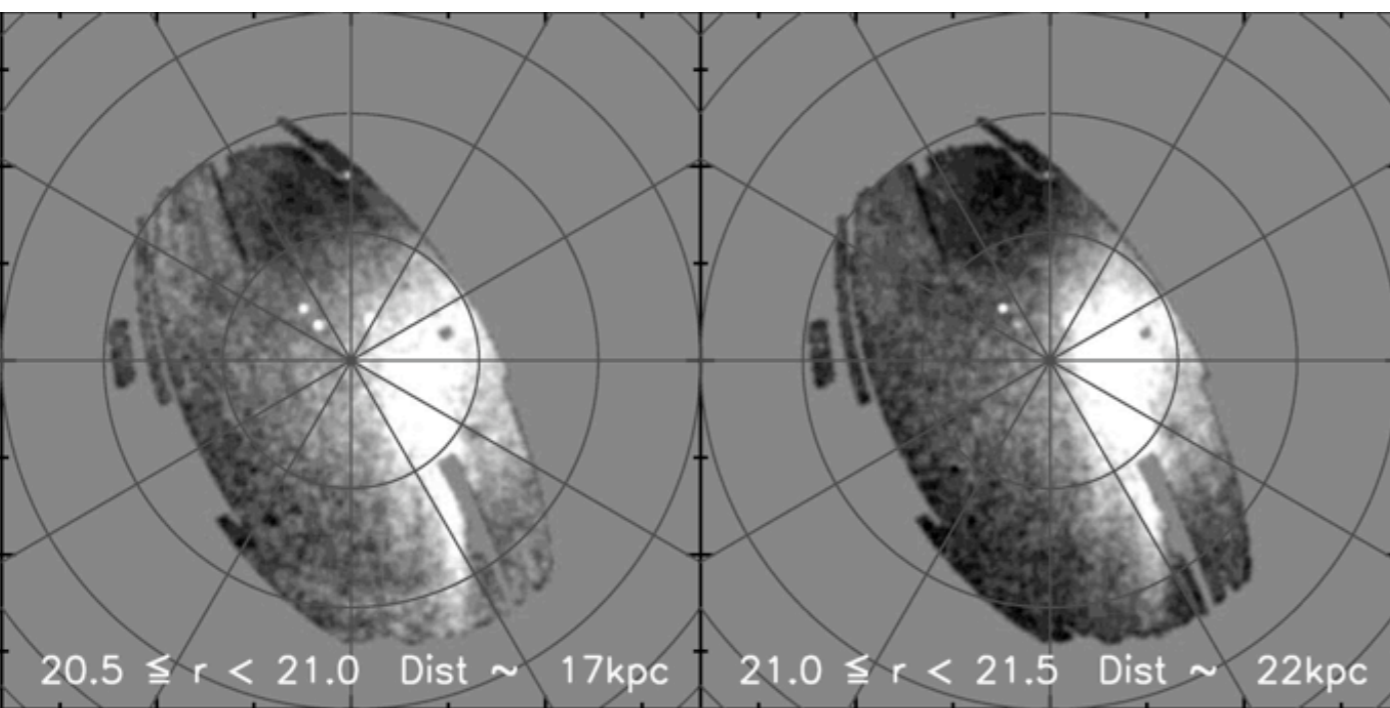
Bell et al. 2008
Substructure in stellar density

• density substructure: recent

• RV substructure: longer-lived

• Estimate: MW accretion ~constant last 5 Gyrs

Schlaufman et al. 2009

- Good stellar tracers of substructure in the outer halo are sparse -- well matched to a wide field spectrograph

- We have become good at finding them, thanks to SEGUE

    - BHBs are easy, need high S/N to separate lower-luminosity blue straggles, get good RVs from wide lines

    - reddest RGBs are several magnitudes more luminous, but rare and are more difficult to separate from dwarfs.

    - exploit mass-metallicity relation to learn about progenitors

    - significant sample gain from going fainter, and more S/N to the SEGUE limit

- Finding true outer-halo stars and measuring kinematics tells us about the MW's accretion of the lowest-mass DM halos

    - pesky problem of relating stars to DM halos

    - MW and very nearby galaxies are rare opportunities to count lowest-mass ΛCDM substructure

- Same calibration data for RGB spectra needed for galaxy stellar populations